RARGOM Workshop

# Development of Ecosystem Indicators for Multiple Management and Research Needs

November 15, 2006
8:30am – 4:30pm
Wells National Estuarine Research Reserve
Wells, Maine

## Workshop Steering Committee

Kevin Friedland, National Marine Fisheries Service
Stephen S. Hale, U.S. Environmental Protection Agency
Ray Konisky, Gulf of Maine Council
Marilyn ten Brink, U.S. Environmental Protection Agency

## Acknowledgements

This theme session was conceived by and planned under the auspices of the Regional Association for Research on the Gulf of Maine (RARGOM), in collaboration with the Gulf of Maine Council, witch provided funding. Lynn Rutter, RARGOM coordinator at UNH, and Ray Konisky made the meeting arrangements that resulted in a successful meeting.

## Overview

RARGOM, the Regional Association for Research on the Gulf of Maine, convened a workshop focusing on the science, development and application of ecosystem-related regional indices. This session built on the 2004 Northeast Coastal Indicators Workshop and other related forums to examine the state of the art, define multiple management needs, and facilitate methods of comparison for indices representing a variety of Gulf of Maine habitats. The workshop touched upon the chemical, physical, biological, geological and socio/economic factors that affect the ecosystem, and contrasted how indices reflect specific measures versus overall ecosystem health. Participants were encouraged to identify the distribution and condition of regional habitats for assessment, protection and restoration, consider methods to combine various data types, and comment on the level of detail and specificity required to achieve index development goals. For the program listing of talk titles, talk abstracts, and addresses of speakers see the appendix.

## Main Findings

The need to develop more predictive models in fishery and environmental management was discussed and reemphasized. Both fishery and environmental models are usually described by retrospective datasets, where future trends are generally inferred without statistical discipline.

Many data tools related to environmental parameters are available, but few are oriented to help users examine trends over time. These tools would better serve resource scientists and managers

if data retrievals to examine time series were incorporated, or graphic tools to examine time series trends were developed.

Current coastal mussel monitoring programs are yielding baseline and trend data related to contaminants. It was recognized that the same sample sites could be used to track climate change events occurring in the Gulf of Maine. The analogy was made to situation with abalone along the California coast where populations have been lost to the progressive temperature change in habitats. It was suggested that investigators doing contaminant sampling seek collaborators to look at population trends in respect to climate change.

The benthic index developed for the Gulf of Maine is being refined, however, it was recognized that it would be desirable to expand the index to include areas in Canadian waters.

Fish size at age is emerging as an important class of index reflecting population status and possibly environmental conditions. Some fish stock are experiencing decreased size at age under decreased catch regimes, which is contrary to what would be expected.

Eel grass is a useful indicator of ecosystem health that was suggested could play an important role in the development of overall indices for the Gulf of Maine.

Though environmental indicators are not reference points in present fishery management schemes, this may change over time. It will be important to select indicators that are not arbitrary and do not lead to the degradation of other parameters.

There was general agreement that remote sensing data and the derivative models being calibrated with these and other data were not begin used to their full potential in developing ecosystem wide indices of thermal habitat and productivity.

It is important to try to integrate socio-economic data into ecosystem models, which participants felt was not being done as effectively as possible at the present time.

Abstracts

**Web-Based Framework for Integrating Ecosystem Indicators in the Gulf of Maine**, Ray Konisky, Gulf of Maine Council

Regionally synthesized indicator reporting is recognized as a critical element of ecosystem-based management (EBM). Reporting partnerships are now organized for several North American regions, including Chesapeake Bay, Great Lakes, Gulf of St. Lawrence, and Puget Sound. In the Gulf of Maine, there is no over-arching governance or funding agency to coordinate EBM activities and reporting, despite extensive monitoring activities within the region. In response, the Gulf of Maine Council on the Marine Environment (GoMC) is promoting the development of a regional indicators program through the creation of the Ecosystem Indicators Partnership (ESIP). ESIP is coordinated by a program manager and directed by a Steering Committee of representatives from the US (NOAA, EPA, and USGS) and Canada (DFO and EC).

Building on the 2004 Northeast Coastal Indicators Workshop and the Gulf of Maine Summit, ESIP recently organized listening sessions to identify a strategy for regional ecosystem indicator development. Participants reaffirmed the importance of integrated, ecosystem-based management of environmental, social, cultural, and economic features, and clearly directed ESIP to harmonize existing indicator and monitoring efforts. These findings were translated into strategic actions for developing regional information infrastructure, building and sustaining partnerships, and communicating to the public and decision-makers. The ESIP approach is organized around six focus areas: eutrophication, aquatic habitats, climate change, coastal development, contaminants, and fisheries and aquaculture (www.gulfofmaine.org/esip/).

In terms of enabling technologies, web-based mapping tools provide an excellent platform for synthesis and spatial reporting of monitoring data. ESIP is actively involved in two web-mapping pilots. A project jointly funded by GoMC and Canadian-based GeoConnections is underway to map and report select nutrient and contaminant monitoring datasets. As a pilot reporting framework, ESIP has also developed a clickable web map showing more than 8,000 monitoring sites in 25 programs. The map is organized by major river basins and color-coded by ESIP focus area to show the extent and type of marine monitoring activity. This synthesized web-based system provides a spatial framework for regional reporting, and also informs the indicator selection process. Moving forward, ESIP will focus on tools and services that foster interdisciplinary participation in the partnership and lead to development of an ecosystem-based reporting system for the Gulf of Maine.

**Gulfwatch Contaminants Indicators**, Steve Jones, University of New Hampshire

**A benthic index for the nearshore Gulf of Maine**, Stephen S. Hale, Atlantic Ecology Division, U.S. Environmental Protection Agency

We developed a benthic index for the Gulf of Maine to provide environmental managers a way to make both spatial and year-to-year comparisons of benthic condition. As part of the National Coastal Assessment, the states of Maine, New Hampshire, and Massachusetts sampled benthic assemblages in estuaries and coastal areas of the U.S. Gulf of Maine each summer beginning in 2000. Logistic regression with several candidate measures of species diversity,

pollution sensitivity-tolerance, and community composition discriminated sites with low and high benthic environmental quality (BEQ), which was based on the concentrations of metal and organic contaminants in the sediments, total organic carbon, sediment toxicity, and dissolved oxygen level of the bottom water at 182 stations. We developed several candidate benthic indices; models using the Shannon-Wiener diversity measure, a species pollution tolerance measure, and the percent capitellid polychaetes (or percent *Capitella* spp.), had a classification accuracy of around 80%. Independent data from Massachusetts Bay and Casco Bay helped us to select and validate the best index. Signal detection theory (ROC and positive-negative predictive value curves) was applied to rigorously evaluate the index and to predict how well an index developed for one geographic area might work in another area with a different prevalence of the degraded condition. These techniques can also guide decisions by environmental managers about thresholds and weighing costs and benefits.

**Fisheries Indicators from fishery dependant and independent data streams**, Paul Rago, National Marine Fisheries Service

**A Multi-Scale Framework for Aquatic Habitat Indicators**, Hilary A. Neckles, U.S. Geological Survey

Aquatic habitats are threatened by diverse human activities, including direct alterations, indirect effects of land management practices, and long-term impacts of a changing global climate. Indicator-based monitoring can improve the ability to detect threats, identify the sources of problems, and suggest management solutions. A nested, three-tiered framework provides an efficient way to document regional status and trends and diagnose causes of habitat change (NSTC, 1997, Integrating the Nation's Environmental Monitoring and Research Networks and Programs: A Proposed Framework, Washington, DC). This framework includes broad inventories and remote sensing (Tier 1), mid-level surveys (Tier 2), and intensive sampling at index sites (Tier 3). Indicator selection at each scale is guided by specific monitoring objectives, and research and modeling integrates information across scales. As part of the National Park Service Vital Signs Monitoring Program, we have tested multi-scale monitoring of eelgrass in Little Pleasant Bay, MA, within Cape Cod National Seashore. This is offered as a case example of this tiered approach to indicator selection and monitoring design. An existing state mapping program provides information on large-scale changes in plant distribution at five-year intervals. We supplemented this information with annual intermediate-resolution measurements on a bay-wide scale and high-resolution measurements at specific sites. Intermediate-resolution monitoring is based on rapid assessments of eelgrass cover, shoot length, and water depth at 200 locations selected by stratified-random sampling. High-resolution monitoring includes measurements of eelgrass condition (percent cover, density, biomass, shoot morphology, epiphyte cover, wasting disease) and environmental characteristics (water depth, light availability, sediment features) within permanent quadrats at different depths, using an adaptation of SeagrassNet sampling methods. Integration across scales permits estimation of eelgrass biomass on a bay-wide scale and identification of potential causes of changes in eelgrass distribution.

**Ecological Indicators: Lessons Learned from the NEUS Fisheries System**, Jason Link, National Marine Fisheries Service

There are wide array of ecosystem indicators proposed for use in a broader ecosystem management context. By necessity these indicators must be multi-disciplinary and representative of the major processes influencing ecosystem status. Yet there also remains the need to vet and cull indicators into a useful subset amenable for resource management. We provide a list of common categories of indicators and then several methods whereby we package such indicators into a form more useful for living marine resource managers. From these methods and an empirical examination of specific ecosystem metrics, we present some example of how one might use these indicators in a decision criteria context.

**Remote sensing ecosystem indicators,** Andrew Thomas, School of Marine Sciences, University of Maine

The advantage of remote sensing data is the ability to synoptically measure the same variable with consistent protocols over large geographic regions and, potentially, over extended time periods. Two indicators of the state of the marine ecosystem that are amenable to measurement from space are surface temperature (SST) and surface chlorophyll concentration. In the Gulf of Maine, a 20+ year time series of NOAA AVHRR data provides systematic views of spatial heterogeneity and weekly to seasonal variability and allows creation of climatologies from which to judge interannual variability. A 9+ year time series of ocean color data from the NASA-sponsored SeaWiFS instrument provides a shorter, but unprecedented ability to view the same variability in chlorophyll concentrations. Examples will be shown from each for both for the Gulf of Maine as a whole and specific locations. Viewing characteristics, potential disadvantages, biases and limitations of these remote sensing based indicators will also be discussed.

**Cross Border Indicators of Climate Change over the Past Century: Northeastern United States and Eastern Canada**, Cameron Wake, University of New Hampshire

See: http://www.cleanair-coolplanet.org/information/pdf/indicators.pdf

**Large Marine Ecosystem models of indicator assessment**, Ken Sherman, National Marine Fisheries Service

**Use of stressor - response indicators in managing estuarine water quality**, Marilyn ten Brink, Atlantic Ecology Division, U.S. Environmental Protection Agency

**ASSETS: Assessment of Estuarine Trophic Status**, Michele Dionne, Wells National Estuarine Research Reserve

**Landscape Scale Ecosystem Indicators: An Overview of the Coastal Change Analysis Program (C-CAP) and Related Tools from the Coastal Services Center**, Betsy Nicholson, NOAA Coastal Services Center

The Coastal Change Analysis Program (C-CAP) is a nationally standardized database of land cover and change information within the coastal regions of the U.S. C-CAP products inventory coastal intertidal areas, wetlands, and adjacent uplands with the goal of monitoring natural and human induced changes in these habitats, on a one-to-five year cycle. C-CAP mapping is conducted in close coordination with state coastal management agencies, and the interagency Multi-Resolution Land Characteristics (MRLC) consortium National Land Cover Database (NLCD). C-CAP land cover data has been used to address several ecosystem scale management issues, such as tracking wetland health (LA), selecting areas for conservation (NJ), managing habitat and development (Casco Bay Watershed, ME), impervious surface estimations (NEMO network), habitat fragmentation analysis (Long Island, NY), nonpoint source pollution assessment (Carmans River, NY), and for regional planning and assessments. CSC has completed 1996 and 2001 data for the Gulf of Maine, and is now working on a third dataset for 2005. C-CAP can serve as a landscape scale ecosystem indicator of human and naturally-induced land cover change, and can flag areas in which rapid change will impact coastal and marine resources. Data is available free of charge from www.csc.noaa.gov/landcover.

# Program

| | Start | Time | Speaker | Institution | Title |
|---|---|---|---|---|---|
| Coffee | 8:30 AM | 0:15 | | | |
| Welcome | 8:45 AM | 0:15 | | | |
| Talk | 9:00 AM | 0:30 | Ray Konisky | GoMC | Web-Based Framework for Integrating Ecosystem Indicators in the Gulf of Maine |
| Talk | 9:30 AM | 0:30 | Steve Jones | UNH | Gulfwatch Contaminants Indicators |
| Talk | 10:00 AM | 0:30 | Steve Hale | EPA | A benthic index for the nearshore Gulf of Maine |
| Coffee | 10:30 AM | 0:15 | | | |
| Talk | 10:45 AM | 0:30 | Paul Rago | NMFS | Fisheries Indicators from fishery dependant and independent data streams |
| Talk | 11:15 AM | 0:30 | Hilary Neckles | USGS | A multi-scale framework for aquatic habitat indicators |
| Talk | 11:45 AM | 0:30 | Jason Link | NMFS | Ecological Indicators: Lessons Learned from the NEUS Fisheries System |
| Lunch | 12:15 PM | 1:00 | | | |
| Talk | 1:15 PM | 0:30 | Andy Thomas | U of Maine | Remote sensing ecosystem indicators |
| Talk | 1:45 PM | 0:30 | Cameron Wake | UNH | Cross Border Indicators of Climate Change over the Past Century: Northeastern United States and Eastern Canada |
| Talk | 2:15 PM | 0:30 | Ken Sherman | NMFS | Large Marine Ecosystem models of indicator assessment |
| Coffee | 2:45 PM | 0:15 | | | |
| Talk | 3:00 PM | 0:30 | Marilyn ten Brink | EPA | Use of stressor - response indicators in managing estuarine water quality |
| Talk | 3:30 PM | 0:30 | Michele Dionne | WNERR | ASSETS: Assessment of Estuarine Trophic Status |
| Talk | 4:00 PM | 0:30 | Betsy Nicholson | NOAA | Landscape Scale Ecosystem Indicators: Tools from the NOAA Coastal Services Center |
| End | 4:30 PM | | | | |

Speakers List and e-mail

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